

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-270212

(43)Date of publication of application : 20.09.2002

BEST AVAILABLE COPY

(51)Int.Cl.

H01M 8/10
H01M 8/24

(21)Application number : 2001-066109

(71)Applicant : DAIDO METAL CO LTD

(22)Date of filing : 09.03.2001

(72)Inventor : KITAGAWA KOJI

KATO EIJI

NARUSE YUKIO

INABA TAKASHI

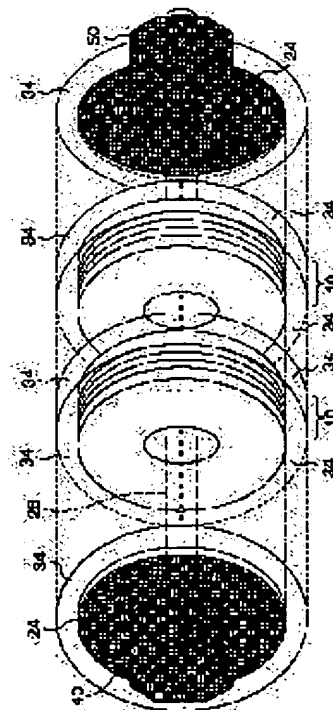
IDO YASUO

(54) PORTABLE FUEL CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a portable fuel cell in which number of components is reduced by decreasing passage plates and the battery performance is improved by lowering the internal resistance by decreasing contact part, and the flow passage resistance is reduced by supplying the fuel directly from the center of the end plate to the fuel distribution manifold.

SOLUTION: The portable fuel cell comprises an end plate, a plurality of unit cells positioned between the two end plates, a fuel distribution manifold that is positioned at the central part of the unit cells and supplies fuel there, a piece of bolt that is penetrated in the central part of the unit cells and the fuel distribution manifold for uniting those members in one body, and a fixing nut that is fitted at the both ends of this bolt through a washer and a O ring or the like and unites the plural unit cells in one body between the end plates. The unit cell comprises a polymer electrolyte membrane, an oxygen pole and a hydrogen pole installed on both sides of the polymer electrolyte membrane, a passage plate installed on the side of oxygen pole, a separator plate installed in contact on the outside of the oxygen pole side passage plate and



on the outside of the hydrogen pole side. And the fixing nut has a fuel supply opening that communicates with the fuel distribution manifold.

LEGAL STATUS

[Date of request for examination] 22.10.2002

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number] 3559246

[Date of registration] 28.05.2004

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Copyright (C); 1998,2003 Japan Patent Office

* NOTICES *

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] Two or more single cells located among two, an end plate and this end plate, The fuel distribution manifold for being located in the core of this single cell and supplying a fuel there, One Thailand bolt which has the core of said fuel manifold and said single cell let it pass in order to make these members into one, And it sets to the pocket mold fuel cell which consists of a nut for immobilization for being screwed on the both ends of this Thailand bolt, and binding said two or more single cells tight between end plates through an O ring etc. at one. Said single cell is a pocket mold fuel cell characterized by including the polyelectrolyte film, the oxygen pole and fuel electrode which were prepared in the both sides of this polyelectrolyte film, the passage plate which adjoined said oxygen pole side, and the separator plate adjoined and formed in the outside of this passage plate, and the outside by the side of said fuel electrode.

[Claim 2] One side of said nut for immobilization is the pocket mold fuel cell indicated by claim 1 characterized by having the feed holes which are open for free passage to said fuel distribution manifold in order to supply a fuel from the center of said end plate.

[Claim 3] Said fuel distribution manifold is the pocket mold fuel cell indicated by claim 1 characterized by forming by arranging the synthetic fiber yarn of a hydrophilic property along the direction of an axis to said tie bolt.

[Claim 4] Another side of said nut for immobilization is the pocket mold fuel cell indicated by claim 1 characterized by providing the bleeder valve which can make said fuel electrode etc. fill up with a fuel by actuation of one-touch in the edge of said bolt.

[Translation done.]

* NOTICES *

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the pocket mold fuel cell using a light and quiet pollution-free solid-state macromolecule mold cell which can be used for various applications, such as outdoor, a power source in a picnic, and a generator for home use.

[0002]

[Description of the Prior Art] Generally, a fuel cell makes hydrogen a main fuel and takes it out as energy when this hydrogen reacts chemically with oxygen. And there are some classes of fuel cells and there is a solid-state polyelectrolyte mold fuel cell as one of them. It has the property that this solid-state polyelectrolyte mold fuel cell has a low operating temperature, and its power density is high.

[0003] As an example of the fuel cell using such a conventional polymer electrolyte fuel cell, there are some which are indicated by the U.S. Pat. No. 5,595,834 specification. As shown in drawing 5, both sides of the solid-state polyelectrolyte film 12 are equipped with the two electrodes of anode (fuel electrode) 13a and cathode (oxygen pole) 13b. Equip those both sides with a fuel and the oxygen passage plates 14 and 18, and the single cel 10 is formed by being made one with the separator plate 34 arranged at those both sides. Accumulate two or more these single cels 10, and it has the fuel distribution manifold which consists of a sleeve 32 of the hydrophilic property connected to the fuel passage plate 14 further through the central hole of the single cel 10. It inserts by forming an end plate 24 in the both ends of the bolt 26 which has the core of a sleeve 32 let it pass further, and there is a thing with the structure fixed to one with the bundle with the nut through washer 38a-38d and O ring 36. Since such a fuel cell is suitable for the fuel cell of low power, it can be made small and lightweight.

[0004] Moreover, so that the hydrophilic sleeve 32 which makes the fuel distribution manifold for supplying a fuel to the passage plate 14 which makes a fuel flow field in this macromolecule electrolytic type fuel cell may be open for free passage The fuel-supply passage plate 29 is arranged between the separator plates 34 of the single cel 10 which adjoins one end plate 24, the port 28 established in the periphery section of an end plate 24 is formed, a fuel is led there, and it is made a configuration which is supplied to the fuel passage plate 14 of a cell.

[0005]

[Problem(s) to be Solved by the Invention] However, in the above conventional electrolyte mold fuel cells, the two electrodes of anode (fuel electrode) 13a and cathode (oxygen pole) 13b are prepared in both sides of the solid-state polyelectrolyte film 12, those both sides are equipped with the fuel passage plate 14 and the oxygen passage plate 18, a contact part will also increase, internal resistance will be large and the engine performance of the whole cell will fall.

[0006] Moreover, since it has the structure which the component parts of the port 28 grade for the fuel supply of the fuel-supply passage plates 14 and 29 by the side of fuel supply and an end plate 24 not only increase in number, but the passage of a fuel feeds toward a center through the passage plate 29 of a fuel flow field from the side of an end plate, while the flow resistance of a fuel-supply way increases, concentration fluctuation of a fuel also becomes large and supply of the stable energy will be affect. And

if component parts increase in number, maintenance will also become troublesome, a configuration also becomes complicated, and a dimension also becomes large.

[0007] This invention aims at offering the pocket mold fuel cell which can decrease passage resistance by being made in view of the above-mentioned technical problem, lessening components mark by reducing a passage plate, reducing the contact section, lowering internal resistance, and raising the cell engine performance, and feeding a fuel into a direct fuel distribution manifold from the core of an end plate.

[0008] Moreover, by lessening a component part, other purposes of this invention are still smaller, and are offering the pocket mold fuel cell which can be lightweight-ized.

[0009]

[Means for Solving the Problem] The first means of this invention for attaining the above-mentioned purpose is characterized by the single cel in an electrolyte mold fuel cell containing the polyelectrolyte film, the oxygen pole and hydrogen pole established in the both sides of this polyelectrolyte film, the passage plate formed in the fuel electrode side, and the separator plate contacted and formed in the outside of an oxygen pole side passage plate, and the outside by the side of a fuel electrode.

[0010] According to this first means, the following operations are done so.

(1) Since it does not have the passage plate formed in the fuel electrode side prepared conventionally, the 2nd page of the part contact surface can decrease, the electric resistance of a contact part can decrease, internal resistance can be decreased, and energy generation of a cell can be made efficient.

[0011] (2) Since the number of components of a single cel decreases, it can consider as a product cheap as a whole, and single cel attachment can also become easy and can raise productive efficiency.

[0012] The second means of this invention is characterized by one side of the nut for immobilization having the feed holes which are open for free passage to a fuel distribution manifold in order to supply a fuel from the center of an end plate.

[0013] With this second means, since (3) fuels are directly supplied to the fuel distribution manifold to a single cel without fuel passage, passage resistance can decrease, and a fuel can be supplied smoothly, and fluctuation of fuel supply can be lessened. Therefore, the stable generation of electrical energy can be performed.

[0014] (4) By having lost the fuel passage in a cell, it becomes possible to be able to lessen the component part for it, to be small and to lightweight-ize a cell further.

[0015] Furthermore, the third means of this invention is characterized by forming, when a fuel distribution manifold arranges the synthetic fiber yarn of a hydrophilic property along the direction of an axis in the Thailand bolt.

[0016] (5) It can choose from the ingredient which is easy to obtain since the synthetic fiber yarn of a hydrophilic property is used, cost does not require the fuel distribution manifold by this third means, either, but since handling is also easy, it can be formed easily.

[0017] Moreover, the fourth means of this invention is characterized by providing the bleeder valve with which another side of the nut for immobilization can supply a fuel to a passage plate etc. by one-touch in the edge of a bolt.

[0018] (6) Since the bleeder valve was provided, the lock nut of another side by this fourth means can be supplied so that a fuel may be enough spread over the fuel electrode plate side of the polyelectrolyte film, and the generation-of-electrical-energy operation at the time of starting can be made to start to it smoothly by actuation of one-touch at the time of starting of a fuel cell.

[0019]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to a drawing.

[0020] Drawing 1 is the perspective view showing the assembly **** condition of the pocket mold fuel cell concerning the gestalt of operation of this invention, and drawing 2 is the decomposition sectional view. This pocket mold fuel cell between the separator plates 34 with a thickness of 0.3mm which is called the polymer electrolyte fuel cell which used fuels, such as hydrogen, and has a bigger diameter than other configuration members made from stainless steel It consists of a carbonaceous material of the

shape of a sheet arranged at the both sides of the solid-state polyelectrolyte film 12 which consists of perfluorocarbon sulfonic acid polymer material with a thickness of 0.05mm, and this solid-state polyelectrolyte film 12. 0.5mm in thickness 0.5mm in fuel electrode 13a which has a dimension with a bore [of 15mm], and an outer diameter of 45mm, thickness 3.5mm in thickness arranged on the outside of oxygen pole 13b which has a dimension with a bore [of 19mm], and an outer diameter of 55mm, and this oxygen pole 13b The bore of 19mm, A dimension with an outer diameter of 55mm A dimension with a width of face [like EPDM which seals the inner circumference section of the outer seal 16 which carried out annular / with a width of face of 2mm which consists of synthetic rubber like EPDM for sealing the periphery section of the oxygen passage plate 18 which consists of a carbonaceous material plate which it has, and fuel electrode 13a /, and the oxygen pole 13b and the oxygen passage plate 18] of 5mm The single cel 10 which has the inner seal 22 which it has is included. With the gestalt of the following operations, a fuel is hydrogen, and oxygen is oxygen in air and is mainly sent as air. Moreover, the solid-state polyelectrolyte film 12 puts the catalyst for a chemical reaction.

[0021] In order to pile up only the number according to the output need for this single cel 10 and to make it one, opening of the central part be carry out, and with the hydrophilic synthetic fiber yarn which become that outside from aromatic polyamide:Kevlar (trade name), the Thailand bolt 26 which have the diameter of 6mm and a dimension with a die length of 100mm surrounded the fuel distribution manifold 32 arrange in the direction of an axis, be attached, and have penetrate. And an end gasket 28 made of synthetic rubber like EPDM is pinched between the separator plate 34 of the outermost single cel 10, and the end plate 24. As opposed to **** cut to the both ends of the Thailand bolt 26 10mm in thickness of the product [nuts / 40 and 50 / made from stainless steel] made of an epoxy resin It is thrust into each of end plates 24 and 24 which has a dimension with a bore [of 15mm], and an outer diameter of 55mm face to face, and two or more single cels 10 can be fixed to one.

[0022] One nut 40 for making such a single cel 10 into one As shown in drawing 3 , while the hollow hole 42 is formed in a core, and the inside **** 46 is cut to the direction center section of an axis in the opposite side and being able to screw in the Thailand bolt 26 At least two passage 44 of a fuel is established in the outside of the inner **** 46, it is open for free passage with the hollow hole 42, and the fuel feed holes which make possible fuel supply to the fuel distribution manifold 32 are made. And the slot 48 of a circle configuration in which O ring 36 is inserted is formed in the field which touches an end plate 24.

[0023] Moreover, as the nut 50 of another side is shown in drawing 2 , like one nut 40, the inside **** 56 is mostly cut to the direction of axis central part so that edge **** of the Thailand bolt 26 may be thrust, and the free passage hole 54 to the fuel distribution manifold 32 is formed in the radial outside. The bleeder valve 52 made from stainless steel in which charge according a fuel to one-touch control is possible is attached in the direction opposite side of an axis of the inner **** 56, and restoration can be assisted by performing the feeding and discarding of the fuel to the fuel distribution manifold 32 and fuel electrode 13a through the free passage hole 54. And the circle configuration slot 58 is formed in the field which touches an end plate 24, and the O ring is inserted in.

[0024] Moreover, the fuel distribution manifold 32 is formed by stretching and passing on a barrel front face and arranging in the direction of an axis by stopping the synthetic fiber yarn 324 of a hydrophilic property, to the flange 322 prepared in the both ends of tubed housing for supply of a fuel, and the generated water absorption maintenance, as shown in drawing 4 .

[0025] The pocket mold fuel cell which has the above configurations can be assembled as follows.

[0026] First, where one nut 40 is beforehand attached in the end of the Thailand bolt 26, it is in the condition stood perpendicularly preferably, and it attaches so that the fuel distribution manifold 32 may be put. Thus, the Thailand bolt 26 on which the fuel distribution manifold 32 was put constitutes the medial axis of a fuel cell.

[0027] So that the outermost end plate 24 and a gasket 28 may be inserted and prepared for that feed hole one by one to this medial axis and the single cel 10 may be constituted The separator plate 34, fuel electrode 13a, It is assembled by inserting in those feed holes the outer seal 16 located in the radial outside, the solid-state polyelectrolyte film 12, the inner seal 22, oxygen pole 13b located in the radial

outside and the oxygen passage plate 18, and the separator plate 34, and putting one by one.

[0028] Then, for the following single cel 10, the outer seal 16 located in fuel electrode 13a and its radial outside like the front single cel 10 to the separator plate 34 of the last of the front single cel 10, the solid-state polyelectrolyte film 12, the inner seal 22, oxygen pole 13b located in that radial outside and the oxygen passage plate 18, and the separator plate 34 are inserted in a medial axis, and are assembled. Only the number according to the regular output of a pocket mold fuel cell is repeated successively, and this single cel 10 is accumulated and assembled.

[0029] Finally, a gasket 28 is pinched as opposed to the separator plate 34 of the outermost single cel 10, the feed hole lets a medial axis pass, and an end plate 24 is accumulated on it. the stack made into the layered product of this single cel 10 -- a predetermined pressure -- for example, it comes out about 15 MPas and is pressed down. in this condition, the nut 50 of another side in which the bleeder valve 52 was attached stuffs the screw thread of the edge of the Thailand bolt 26 of a medial axis -- having -- the whole of a stack -- predetermined torque -- for example, 6.8Nm comes out, and it binds tight and fixes.

[0030] As a pocket mold fuel cell, a tube etc. is further connected to the fuel cell assembled as mentioned above so that the fuel from a hydrogen generator etc. may be supplied to one nut 40. Fuels, such as hydrogen, are supplied to the fuel distribution manifold 32 through the hollow hole 42 and the fuel passage 44 which make the fuel feed holes of one nut 40, and are sent to the toe of fuel electrode 13a of each ** cel 10 by the fuel distribution manifold 32 which met the tension bolt 26. Since it consists of a sheet-like carbonaceous material, and it could send to radial and the periphery section is sealed with the outer seal 16, without letting the opening of the porous ingredient pass and forming a fuel passage plate specially, fuel electrode 13a can be sent so that the solid-state polyelectrolyte film 12 may be supplied. Since oxygen pole 13b and the oxygen passage plate 18 are formed in the opposite side of this solid-state polyelectrolyte film 12, air is sent by the opening of the foam of the oxygen passage plate 18 from an outside, and the oxygen in air is supplied to oxygen pole 13b.

[0031] Thus, it reacts chemically there, a fuel electrode turns into an anode plate, an oxygen pole turns into cathode, and the fuel and oxygen which were sent to the both sides of the solid-state polyelectrolyte film 12 perform a generation-of-electrical-energy operation. Moreover, in the fuel distribution manifold 32, since the water generated by the hydration in that case although accompanied by generating of water and generation of heat is absorbed by hydrophilic synthetic fiber yarn 324, the water generated in the fuel distribution manifold 32 collects, and it does not prevent supply of the fuel to fuel electrode 13a. Moreover, with the generated heat, water evaporates and carries out and stripping is carried out into atmospheric air. Moreover, since the separator plate 34 has the dimension with a bigger radius than other configuration members, it can operate the part projected from other configuration members so that heat might be radiated in the generated heat as a radiation fin.

[0032] Moreover, since supply of the fuel to fuel electrode 13a carries out directly, without forming a fuel passage plate, there are few components which contact, internal resistance can become small, and it can carry out stable maintenance of the engine performance of a fuel cell as its part which contacts directly decreased, and the number of components can reduce a manufacturing cost by ***** few.

Since the hydrogen gas molecule which is a fuel is formed with foam in fuel electrode 13a by

[smallest] being a molecule as compared with other gas, even if fuel passage is not used for this, it is because a hydrogen content child can reach the macromolecule electrolysis film 12 promptly.

[0033] In addition, the dimension in each configuration member of the above-mentioned example is not limited to them, and, to say nothing of being only an example, is determined according to the output demanded according to an application.

[0034]

[Effect of the Invention] The pocket mold fuel cell concerning this invention does the following effectiveness so by the configuration explained above. In the above-mentioned pocket mold fuel cell, since the single cel has only the fuel electrode between separator plates in the fuel electrode side of the polyelectrolyte film, a fuel will be supplied to direct radial along with the polyelectrolyte film with a fuel electrode, and becomes only a contact part with a fuel electrode, the internal resistance by it decreases, and there is outstanding effectiveness that energy generation of a cell can be performed

efficiently.

[0035] Moreover, it is effective in the ability for the number of components of a single cel to decrease, make it simple structure, and make it a product cheap as a whole.

[0036] Moreover, since feed holes were prepared in the nut for immobilization for carrying out the laminating of the single cel and binding tight to one in order to supply a fuel to a fuel cell from the exterior Since passage resistance [in / in supplying a direct fuel distribution manifold / **** and fuel supply] decreases and a component part can be lessened, without preparing independently the member for some end plates or supply It is effective in it being still smaller as a pocket mold fuel cell, and being able to make it a lightweight thing.

[0037] Moreover, since the synthetic fiber yarn of a hydrophilic property was used for the fuel distribution manifold, it is effective in the ability to form a fuel distribution manifold easily with the ingredient which is easy to obtain, without using special equipment.

[0038] furthermore -- since the bleeder valve was prepared in the nut of the opposite side with the side which has the fuel feed holes of the nut for immobilization -- the time of starting of a fuel cell -- actuation of one-touch -- restoration of the fuel to a fuel electrode -- it can carry out -- the generation-of-electrical-energy operation at the time of starting -- an early stage -- and it is effective in the ability to rise smoothly.

[Translation done.]

* NOTICES *

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the outline perspective view of the pocket mold fuel cell by the gestalt of 1 operation of this invention.

[Drawing 2] It is the decomposition sectional view of the pocket mold fuel cell shown in drawing 1 .

[Drawing 3] The lock nut by the side of the fuel supply used for the pocket mold fuel cell shown in drawing 1 is shown, and the sectional view where (A) met line IIIA-IIIA, and (B) are the front views seen from the right-hand side of (A).

[Drawing 4] It is the side elevation of a fuel distribution manifold used for the pocket mold fuel cell shown in drawing 2 .

[Drawing 5] It is decomposition drawing of longitudinal section of the conventional macromolecule mold fuel cell.

[Description of Notations]

- 10 Single Cel
- 12 Solid-state Polyelectrolyte Film
- 13a Fuel electrode
- 13b Oxygen pole
- 16 Outer Seal
- 18 Oxygen Passage Plate
- 22 Inner Seal
- 24 End Plate
- 26 Tie Bolt
- 28 And Gasket
- 32 Fuel Distribution Manifold
- 34 Separator Plate
- 36 O Ring
- 40 Nut
- 42 Hollow Hole
- 44 Fuel Passage
- 46 Inner ****
- 48 Circle Configuration Slot
- 50 Nut
- 52 Bleeder Valve
- 54 Free Passage Hole
- 56 Inner ****
- 58 Circle Configuration Slot
- 322 Flange
- 324 Synthetic Fiber Yarn

[Translation done.]

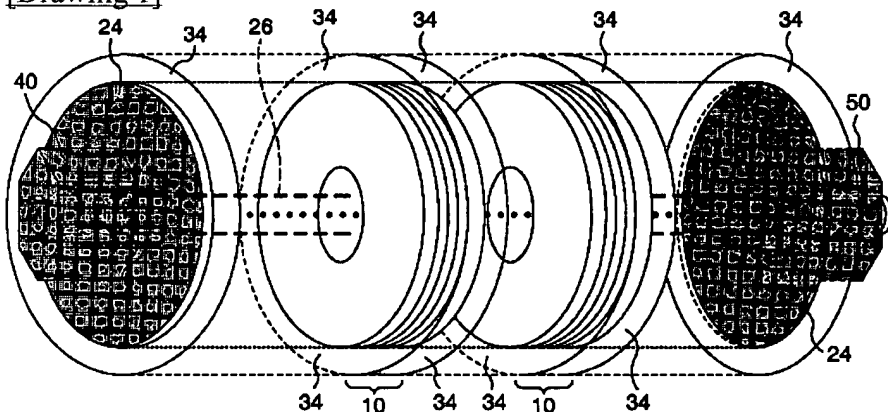
* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

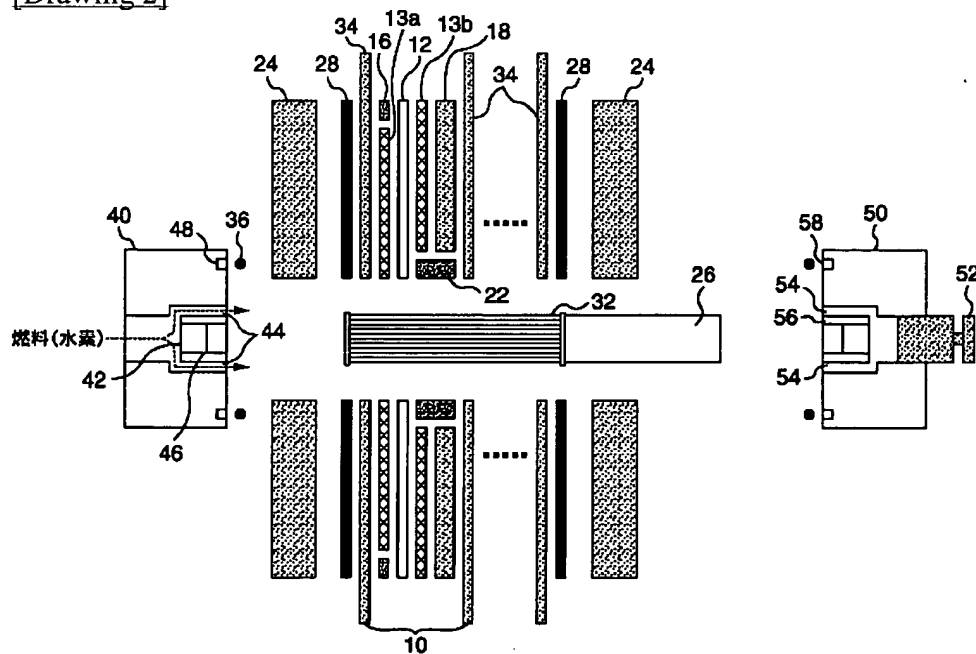
- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DRAWINGS

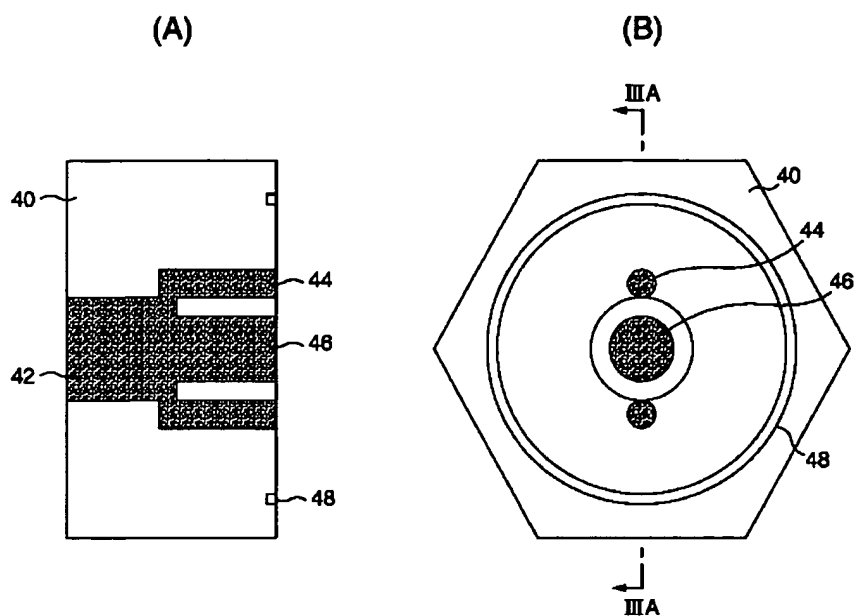
[Drawing 1]



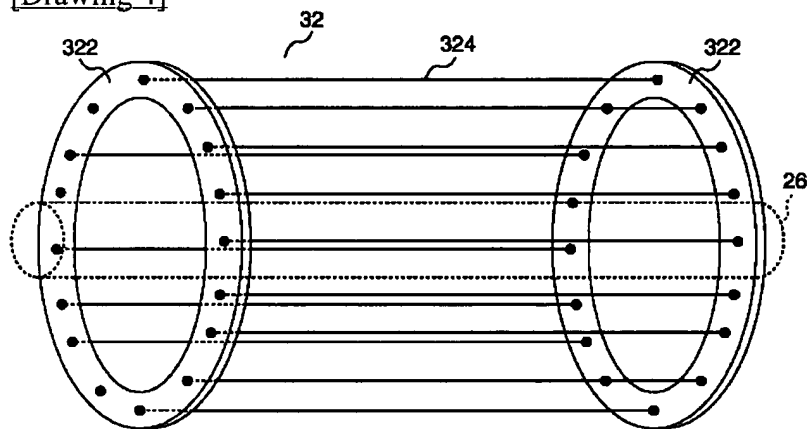
[Drawing 2]



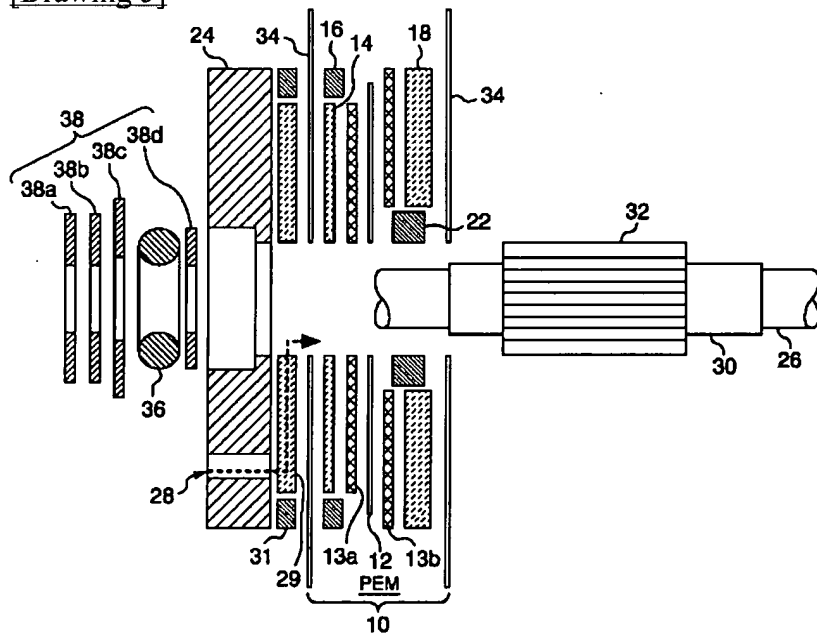
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]

AB

MENU

SEARCH

INDEX

DETAIL

JAPANESE

1 / 1

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-270212

(43)Date of publication of application : 20.09.2002

(51)Int.Cl.

H01M 8/10

H01M 8/24

(21)Application number : 2001-066109

(71)Applicant : DAIDO METAL CO LTD

(22)Date of filing : 09.03.2001

(72)Inventor : KITAGAWA KOJI

KATO EIJI

NARUSE YUKIO

INABA TAKASHI

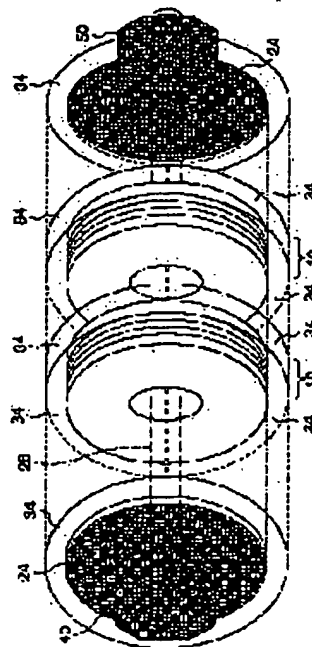
IDO YASUO

(54) PORTABLE FUEL CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a portable fuel cell in which number of components is reduced by decreasing passage plates and the battery performance is improved by lowering the internal resistance by decreasing contact part, and the flow passage resistance is reduced by supplying the fuel directly from the center of the end plate to the fuel distribution manifold.

SOLUTION: The portable fuel cell comprises an end plate, a plurality of unit cells positioned between the two end plates, a fuel distribution manifold that is positioned at the central part of the unit cells and supplies fuel there, a piece of bolt that is penetrated in the central part of the unit cells and the fuel distribution manifold for uniting those members in one body, and a fixing nut that is fitted at the both ends of this bolt through a washer and a O ring or the like and unites the plural unit cells in one body between the end plates. The unit cell comprises a polymer electrolyte membrane, an oxygen pole and a hydrogen pole installed on both sides of the polymer electrolyte membrane, a passage plate installed on the side of oxygen pole, a separator plate installed in contact on the outside of the oxygen pole side passage plate and on the outside of the hydrogen pole side. And the fixing nut has a fuel supply opening that communicates with the fuel distribution manifold.



LEGAL STATUS

[Date of request for examination]

22.10.2002

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☐ **BLACK BORDERS**

☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**

☐ **FADED TEXT OR DRAWING**

☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**

☐ **SKEWED/SLANTED IMAGES**

☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**

☐ **GRAY SCALE DOCUMENTS**

☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**

☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**

☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.